THE DESIGN AND IMPLEMENTATION OF A STATEWIDE PERINATAL AUTOMATED MEDICAL NETWORK FOR MICHIGAN (PAM/NET)

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ABSTRACT

PAM/NET is a multi-institutional computer based Neonatal research data base and conferencing system using a large university based mainframe computer (Amdahl 470/V8). The data base functions are provided by a sophisticated inverted file relational data base management system (MICRO) developed by the Institute for Labor and Industrial Relations. The conferencing system (Confer) supports open continuing discussions, bulletins, and private messaging. The design of the PAM/NET system was specifically tailored to encourage and foster sharing data between institutions, while supporting their needs for confidentiality and data security.

BACKGROUND

The system's development began in 1978 when the Neonatology unit at the Children's Hospital of Michigan instituted a computerized Neonatal data base. This data base consisted of clinical summary information which covered demographics, prenatal conditions, intrapartum conditions, birth information, diagnoses, treatments, complications, and immediate outcome.[1] In addition, a program was devised to generate a summary report for each case which appeared to be a narrative summary of the hospital course of the infant in the form of a letter to the referring physician.[2]

In 1982, the State of Michigan Department of Mental Health sought resources for a perinatal data base system which would aid statewide studies in perinatal outcome, and facilitate tracking high-risk newborn infants through their medical follow-up process in Developmental Assessment programs (DAC's).

The Perinatal Association of Michigan (PAM) was selected and provided funding to develop such a system. The Neonatology Unit and the Computer and Informatics Research Division of the Children's Hospital of Michigan were jointly appointed by PAM to develop the software, training materials, and plans for implementation and distribution of the system. The following is a description of the project and our progress to get all of the tertiary care Neonatal units (Level III) and their associated Developmental Assessment Clinics into a common data storage and retrieval network to facilitate the ultimate pooling of important clinical and community health information.

SYSTEM DESCRIPTION

The PAM/NET system resides on a computer (Amdahl 470/V8) that is connected to the MERIT Network. This is a network of university computers in Michigan. MERIT sites are located at five Michigan universities. In addition, the MERIT network maintains connections to the Telenet and Automet national networks and to Datapac, the Canadian counterpart. Thus access to the PAM/NET System is easily available to most users via standard telephone lines without long distance calls. The system is divided into PAMTALK and PAMDATA.

Database System

PAMDATA is the data storage and retrieval system. It is implemented through a relational data base management system (Micro) providing four basic data types, each with several subtypes or definable characteristics. Character type variables may be defined to be a fixed length up to 256. Numeric variables may be defined as integers, or as real numbers using scaling to define the number of decimal places. Numberic variables at definition are assigned a length of 1 to 4 four bytes and may be signed or unsigned. Categorical variables are stored as integer numbers which correspond to labels (11 character), abbreviations (4 characters), and descriptions (256 characters) stored in the data dictionary. The integer value, label, or abbreviation may be used at data entry or output at the user's convenience. External variables are stored pointers to lines of an external character file. The pointers require only 4 bytes of fixed storage, while the character data stored in the external file uses a variable length record up to 32000. This efficiently permits storage of narrative information about the patient in as much as no large fixed space is necessarily reserved. This is a desirable characteristic especially when such data is not necessary for all records.

The perinatal data is stored in five separate relational sets. Though any member institution may have additional sets defined for their specific needs. AUMDATA is the set of information

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available to the clinicians when an infant is admitted to the special care unit. DISCHDATA is the remaining clinical information that is gathered during the hospital stay and is derived from the infant's medical record at discharge. The third data set was developed for the storage of demographic, social, and clinical information collected in the follow-up Developmental Assessment Clinic (DACDATA). These three patient records are related though a common medical record number. In addition, each institution stores a data set with names and addresses of referring physicians and signature blank data for their own medical staff. Relational keys to these sets are stored in the clinical sets so that these pieces may be added automatically to reports and letters generated by the system. Data forms are used to facilitate collection of the data from the medical records (figures 1 & 2).

Data retrieval is available on the system in at least three forms. The first form of data retrieval is provided by the query language offered by the data base management system. This query language supports many relational operations (e.g. join and combine). It also provides subset formation with selection criteria using a SQL type of language (e.g. FIND IN ADMDATA WHERE BIRTHWEIGHT < 1250 AND SEX IS MALE --or-- FIND IN DISCHDATA WHERE DATE.OF.DISCHARGE IS FROM 840101 TO 841231). With the query language, new fields can be computed from existing data and simple statistics may be reported (e.g. mean, minimum, maximum, count, variance, and crosstabulation). The query command language also contains several options for outputting the data in tabular format.

Secondly, there are formatted narrative summaries that can be generated on admission from the data contained in ADMDATA, on discharge from ADMDATA and DISCHDATA, or after a DAC visit from all three clinical data sets. These summaries take data from the relevant sets to produce a narrative summary (figure 3). In the summary, the patient is referred to using his/her name or appropriate pronoun depending on the value of the sex field in the ADMDATA set. Similarly, decision trees are used thoughout the summary production to change the syntax and content depending on the value of data elements in the record This is accomplished with a symbolic language developed by one of us (GEC) which facilitates easy composition of complex data sensitive narrative output of record field values (figure 4).

The third form of data retrieval depends on the database management system's ability to perform a predefined series of commands (macro language) with variable passing at execution. Standard reports may be "programmed" in this language for later execution with a simple macro command.

Data entry and the altering of data are facilitated in an interactive way by the data base management system. The system contains shortcuts to manual data entry by providing user defined default values and type-ahead entry. Transaction file processing subroutines permit batch data entry or editing. This makes possible off-line microcomputer based data entry mechanisms.

The issue of confidentiality and security was important to the institutions participating in this project. The issue was handled by having the data for each institution stored in computer files that are their own. No indiviual can access the data files without a four character sign on identifier assigned by the project director, a password (up to 12 characters) set locally, and proper file access permission status set by the institution representitive. Since common data dictionaries are used, data sharing is easily accomplished. Subsets of the data (excluding personal identifiers) may be selected and made available to other institutions.

Conferencing

PAMTALK is a computer based conferencing system using the Confer program developed by Advertel Corporation (Ann Arbor, MI)[3]. Each person using the system becomes a member of the conference. The conferencing program permits three types of communications. 1) Continuing open discussions can be initiated by any member. Responses to open discussion are chained as other members add to the discussion in progress.

Members may view any entire discussion item or only those responses not yet seen. There may be any number of simultaneous ongoing discussion items, each with their chain of responses. The discussion items are organized post-hoc with an agenda that allows members to find items according to topic. Agenda categories are created by the conference director as needed. A discussion item may be indexed under several agenda topic categories. 2) Bulletins are paragraphs of information which may be posted by any member. Other participants may not respond to bulletins. At the time of posting, the bulletin is given an effective date upon which it will appear and an ending date, after which it will be automatically removed. At each entry into the conference, a member is automatically presented with any bulletin not yet seen. 3) Messages are private communications between members. These conversations are composed of chains of alternating responses, but viewing is restricted by naming participants as is customary in electronic mail. The conference has proven very useful to announce new features of the network, gather opinions proposed about modifications to the system, and continue the training process for users long after the initial training sessions are completed.

STATUS REPORT

Once the system was designed, a detailed user's manual was written and checked by novices for clarity. We invited individuals from five pilot sites into our institution for an all-day orientation which included an overview of the system

and practice with each of its parts using practice data sets.

This workshop was received enthusiastically, but only one of the pilot sites actually continued with little trouble to use the system after the workshop. That one site was the only one that had equipment in place upon returning home. All of the others had ordered equipment ($2000 --6000), but had not received it. For these four institutions, the enthusiasm and knowledge gathered at the workshop soon faded. Three of them had some equipment problems when they were able to implement the system locally that discouraged them easily because they had trouble differentiating hardware problems from problems with the software or their understanding of it. While these problems were resolved, it required a visit to their site to do so.

Hardware problems encountered in the initial implementation phase included a new printer that was malfunctioning, the use of a telephone line that featured a second-caller signal that periodically interjected noise, microcomputers delivered without the necessary accessories for communication, and very delayed ordering or delivery. Since this experience, we have insisted that new institutions joining the system purchase and test their equipment in advance, and that all training be done at their institution on the equipment which will be routinely used. Most start-up problems have been eliminated by this simple prerequisit. Furthermore, we have found that successful implementation was especially enhanced by having one person at the institution dedicated to the task of using the PAM/NET system and only much later bringing others in. Too early distribution of responsibility for system use within an institution slows the development of the local resource person. Once the local resource person has gained some facility in using the basic parts of the system, including the conference, that individual finds a host of creative ways to use the system to serve the local needs. He/she then begins to teach others to use the system with enthusiasm and conviction of the utility of the system.

Now that the pilot project is completed, three of the pilot sites have taken over the cost of keeping it running for their institutions. In addition to these, and the home site at CHM, three additional sites in Michigan and one in Illinois have also joined the system. Of the two pilot sites which chose not to continue, one never was able to acquire adequate hardware, through misunderstandings and lack of administrative follow though. The other had a long delay between training and obtaining the hardware, lost what enthusiam they had, and were very frustrated in relearning the system. They gave up very early in the piloting. At the onset of the project, it was felt that the referral letter writing routines would help justify the cost of data entry and system maintenence. The results have been mixed. Three of the current users are making extensive use of the letters, one some, and the other four sites do not use this feature.

All of the sites find that the access to the clinical and demographic data justify the money and effort. Some multi-institutional studies have already been suggested. At least one research project has been submitted for publication based on data collected and analysed via the system.[5]

FUTURE PLANS

Currently expansion of the system has not proceeded as was expected. This may be due in large part to the absence of governmental funding that was expected. It is believed that several institutions which have expressed interest in joining have delayed the decision waiting to see it State funding will be extended. The current cost for computer time for a typical site is about $4000 per year. Thus the 18 level III hospitals in Michigan could be supported for under $75,000 per year. Present development of the system is centered about designing a microcomputer based component for the system which will distribute some of the data entry and editing functions. This will increase the initial cost (purchase of a microcomputer rather than simply a terminal), but reduce the ongoing cost. Further incentives to join the system are expected to come from the sponsoring organization, the Perinatal Association of Michigan. We hope to have all eighteen level III perinatal centers in Michigan enrolled in PAM/NET in the coming year.

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1. Poland, RL, Bollinger, RO, and Cummings, GE: A statewide Perinatal Automated Medical Network for Michigan (PAM/NET). Perinatology-Neonatology (in press), 1985.

2. Poland, RL and Cummings, GE: Computer generated neonatal discharge summary letter. In Harris, T and Bahr, J. The use of computers in perinatal medicine. Praeger, NY, 1982, pp. 213-217.

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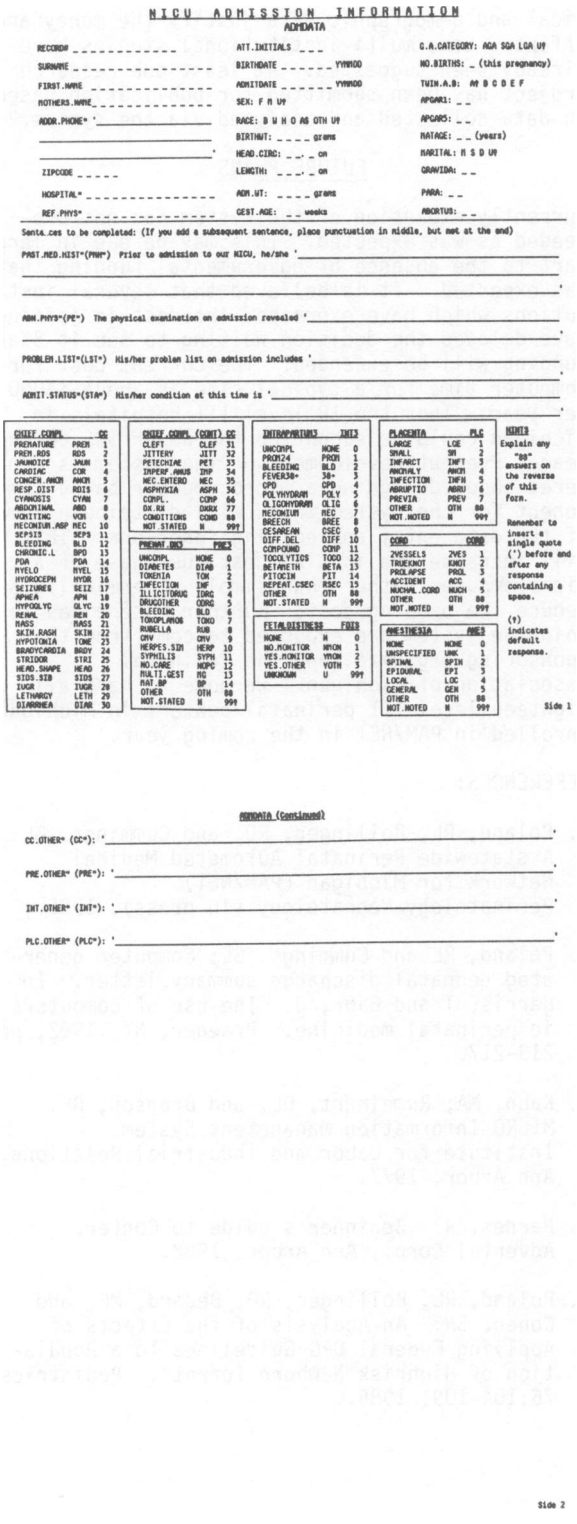


NICU ADMISSION INFORMATION

ADMDATA

RECORD# _ _ _ _ _ _ _ _ _ _ _ _

SURNAME _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

FIRST.NAME _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

MOTHERS.NAME _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

ADDR.PHONE* '_____

_____

_____'

ZIPCODE _ _ _ _ _

HOSPITAL* _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

REF.PHYS* _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

ATT.INITIALS _ _ _

BIRTHDATE _ _ _ _ _ _ YYMMDD

ADMITDATE _ _ _ _ _ _ YYMMDD

SEX: F M UY

RACE: B W H O AS OTH UY

BIRTHWT: _ _ _ _ grams

HEAD.CIRC: _ _._ cm

LENGTH: _ _ _._ cm

ADM.WT: _ _ _ grams

GEST.AGE: _ _ weeks

G.A.CATEGORY: AGA SGA LGA UY

NO.BIRTHS: _ (this pregnancy)

TWIN.A.B: AY B C D E F

APGAR1: _ _

APGAR5: _ _

NATAGE: _ _ (years)

MARITAL: M S D UY

GRAVIDA: _ _

PARA: _ _

ABORTUS: _ _

Sentences to be completed: (If you add a subsequent sentence, place punctuation in middle, but not at the end)

PAST.MED.HIST*(PMH*) Prior to admission to our NICU, he/she '_____

ABN.PHYS*(PE*) The physical examination on admission revealed '_____

PROBLEM.LIST*(LST*) His/her problem list at admission includes '_____

ADMIT.STATUS*(STA*) His/her condition at this time is '_____

CHIEF.COMPL	CC
PREMATURE	PREM 1
PREM.ROS	ROS 2
JAUNDICE	JAUN 3
CARDIAC	COR 4
CONGEN.ANOM	ANOM 5
RESP.DIST	RDIS 6
CYANOSIS	CYAN 7
ABDOMINAL	ABD 8
VOMITING	VOM 9
MECONIUM.ASP	MEC 10
SEPSIS	SEPS 11
BLEEDING	BLD 12
CHRONIC.L	BPD 13
PDA	PDA 14
MYELO	MYEL 15
HYDROCEPH	HYDR 16
SEIZURES	SEIZ 17
APNEA	APN 18
HYPOGLYC	GLYC 19
RENAL	REN 20
RASS	RASS 21
SKIN.RASH	SKIN 22
HYPOTONIA	TONE 23
BRADYCARDIA	BRADY 24
STRIDOR	STRI 25
HEAD.SHAPE	HEAD 26
SIDS.SIB	SIDS 27
IUGR	IUGR 28
LETHARGY	LETH 29
DIARRHEA	DIAR 30

CHIEF.COMPL (CONT)	CC
CLEFT	CLEF 31
JITTERY	JITT 32
PETECHIAE	PET 33
IMPERF.ANUS	IMP 34
NEC.ENTERO	NEC 35
ASPHYXIA	ASPH 36
COMPL.	COMP 66
Dx.RX	DxRX 77
CONDITIONS	COND 88
NOT.STATED	N 999

PRENAT.DX3	PNC3
UNCOMPL	NONE 0
DIABETES	DIAB 1
TOXEMIA	TOX 2
INFECTION	INF 3
ILLICITDRUG	IDRG 4
DRUGOTHER	ODRG 5
BLEEDING	BLD 6
TOXOPLAMOS	TOXO 7
RUBELLA	RUB 8
CMV	CMV 9
HERPES.SIM	HERP 10
SYPHILIS	SYPH 11
NO.CARE	NOPC 12
MULTI.GEST	MG 13
PAT.BP	BP 14
OTHER	OTH 88
NOT.STATED	N 999

INTRAPARTUM3	INT3
UNCOMPL	NONE 0
PROM24	PROM 1
BLEEDING	BLD 2
FEVER38+	38+ 3
CPD	CPD 4
POLYHYDRAM	POLY 5
OLIGOHYDRAM	OLIG 6
MECONIUM	MEC 7
BREECH	BREE 8
CESAREAN	CSEC 9
DIFF.DEL	DIFF 10
COMPOUND	COMP 11
TOCOLYTICS	TOCO 12
BETAMETH	BETA 13
PITOCIN	PIT 14
REPEAT.CSEC	RSEC 15
OTHER	OTH 88
NOT.STATED	N 999

FETALDISTRESS	FDIS
NONE	N 0
NO.MONITOR	MNON 1
YES.MONITOR	MYON 2
YES.OTHER	YOTH 3
UNKNOWN	U 999

PLACENTA	PLC
LARGE	LGE 1
SMALL	SM 2
INFARCT	INFT 3
ANOMALY	ANOM 4
INFECTION	INFN 5
ABRUPTIO	ABRU 6
PREVIA	PREV 7
OTHER	OTH 88
NOT.NOTED	N 999

CORD	CORD
2VESSELS	2VES 1
TRUEKNOT	KNOT 2
PROLAPSE	PROL 3
ACCIDENT	ACC 4
NUCHAL.CORD	NUCH 5
OTHER	OTH 88
NOT.NOTED	N 999

ANESTHESIA	ANES
NONE	NONE 0
UNSPECIFIED	UNK 1
SPINAL	SPIN 2
EPIDURAL	EPI 3
LOCAL	LOC 4
GENERAL	GEN 5
OTHER	OTH 88
NOT.NOTED	N 999

HINTS

Explain any "no" answers on the reverse of this form.

Remember to insert a single quote (') before and after any response containing a space.

(*) indicates default response.

Side 1

ADMDATA (Continued)

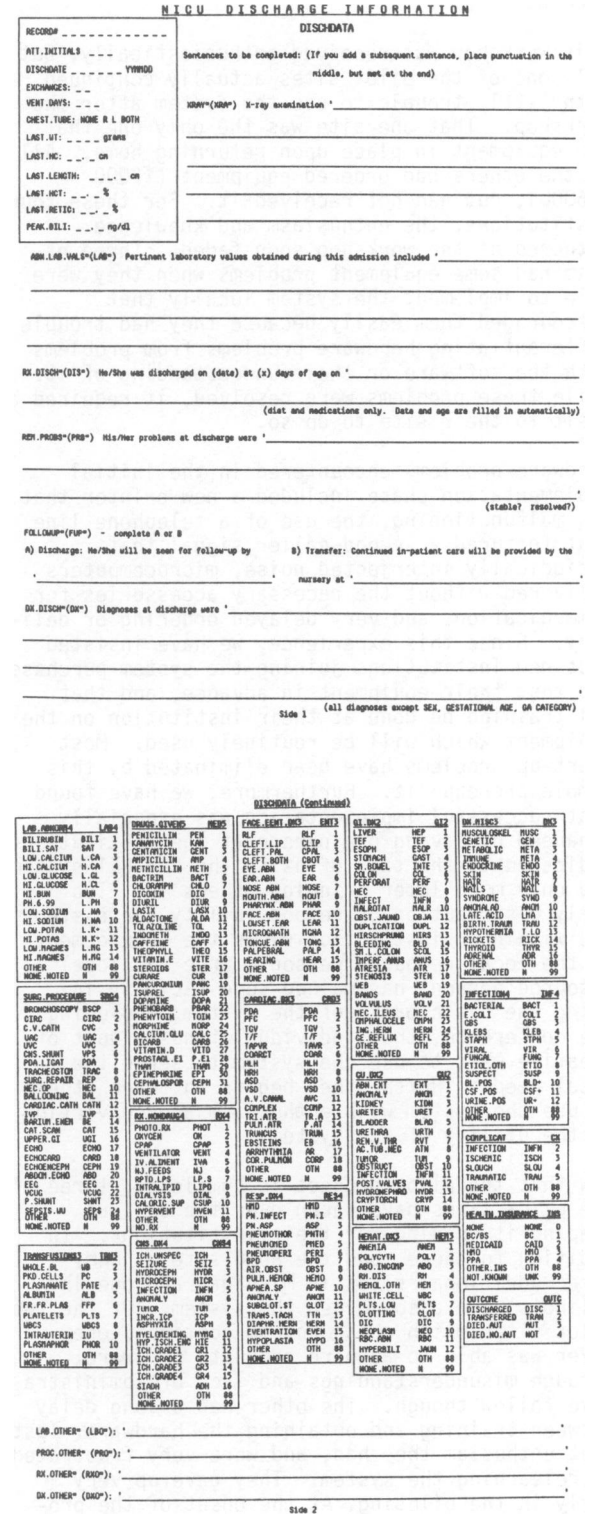
CC.OTHER* (CC*): '_____

PRE.OTHER* (PRE*): '_____

INT.OTHER* (INT*): '_____

PLC.OTHER* (PLC*): '_____

Side 2



NICU DISCHARGE INFORMATION

DISCHDATA

RECORD# _ _ _ _ _ _ _ _ _ _ _ _

ATT.INITIALS _ _ _

DISCHDATE _ _ _ _ _ _ YYMMDD

EXCHANGES: _ _

VENT.DAYS: _ _ _

CHEST.TUBE: NONE R L BOTH

LAST.WT: _ _ _ _ grams

LAST.HC: _ _._ cm

LAST.LENGTH: _ _ _._ cm

LAST.HCT: _ _._ %

LAST.RETIC: _ _._ %

PEAK.BILI: _ _._ mg/dl

Sentences to be completed: (If you add a subsequent sentence, place punctuation in the middle, but not at the end)

XRAY*(XRA*) X-ray examination '_____

ABN.LAB.VALS*(LAB*) Pertinent laboratory values obtained during this admission included '_____

RX.DISCH*(DIS*) He/She was discharged on (date) at (x) days of age on '_____

(diet and medications only. Data and age are filled in automatically)

RSN.PROBS*(PRB*) His/Her problems at discharge were '_____

(stable? resolved?)

FOLLOWUP*(FUP*) - complete A or B

A) Discharge: He/She will be seen for follow-up by '_____'

B) Transfer: Continued in-patient care will be provided by the nursery at '_____'

DX.DISCH*(DX*) Diagnoses at discharge were '_____

(all diagnoses except SEX, GESTATIONAL AGE, GA CATEGORY)

Side 1

DISCHDATA (Continued)

LAB.ABNORM4	LAB4
BILIRUBIN	BILI 1
BILI.SAT	SAT 2
LOW.CALCIUM	L.CA 3
HI.CALCIUM	H.CA 4
LOW.GLUCOSE	L.GL 5
HI.GLUCOSE	H.GL 6
HI.BUN	BUN 7
PH.6.99	L.PH 8
LOW.SODIUM	L.NA 9
HI.SODIUM	H.NA 10
LOW.POTAS	L.K+ 11
HI.POTAS	H.K+ 12
LOW.MAGNES	L.MG 13
HI.MAGNES	H.MG 14
OTHER	OTH 88
NONE.NOTED	N 99

SURG.PROCEDURE	SRG4
BRONCHOSCOPY	BSCP 1
CIRC	CIRC 2
C.V.CATH	CVC 3
UAC	UAC 4
UVC	UVC 5
CNS.SHUNT	VPS 6
PDA.LIGAT	PDA 7
TRACHEOSTOM	TRAC 8
SURG.REPAIR	REP 9
NEC.OP	NEC 10
BALLOONING	BAL 11
CARDIAC.CATH	CATH 12
IVP	IVP 13
BARIUM.EMEN	BE 14
CAT.SCAN	CAT 15
UPPER.GI	UGI 16
ECHO	ECHO 17
ECHOCARD	CARD 18
ECHOENCEPH	CEPH 19
ABDOM.ECHO	ABD 20
EEG	EEG 21
VCUG	VCUG 22
P.SHUNT	SHNT 23
SEPSIS.WU	SEPS 24
OTHER	OTH 88
NONE.NOTED	N 99

IRANSFUSION3	TRN3
WHOLE.BL	WB 2
PKD.CELLS	PC 3
PLASMANATE	PATE 4
ALBUMIN	ALB 5
FR.FR.PLAS	FFP 6
PLATELETS	PLTS 7
WBCS	WBCS 8
INTRAUTERIN	IU 9
PLASMAPHOR	PHOR 10
OTHER	OTH 88
NONE.NOTED	N 99

DRUGS.GIVEN5	MED5
PENICILLIN	PEN 1
KANAMYCIN	KAN 2
GENTAMICIN	GENT 3
AMPICILLIN	AMP 4
METHICILLIN	METH 5
BACTRIM	BACT 6
CHLORAMPH	CHLO 7
DIGOXIN	DIG 8
DIURIL	DIUR 9
LASIX	LASX 10
ALDACTONE	ALDA 11
TOLAZOLINE	TOL 12
INDOMETH	INDO 13
CAFFEINE	CAFF 14
THEOPHYLL	THEO 15
VITAMIN.E	VITE 16
STEROIDS	STER 17
CURARE	CUR 18
PANCURONIUM	PANC 19
ISUPREL	ISUP 20
DOPAMINE	DOPA 21
PHENOBARB	PBAR 22
PHENYTOIN	TOIN 23
MORPHINE	MORP 24
CALCIUM.GLU	CALG 25
BICARB	CARB 26
VITAMIN.D	VITD 27
PROSTAGL.E1	P.E1 28
TMAM	TMAM 29
EPINEPHRINE	EPI 30
CEPHALOSPOR	CEPH 31
OTHER	OTH 88
NONE.NOTED	N 99

RX.MONDRUG4	RX4
PHOTO.RX	PHOT 1
OXYGEN	OX 2
CPAP	CPAP 3
VENTILATOR	VENT 4
IV.ALIMENT	IVA 5
NJ.FEEDS	NJ 6
RPTD.LPS	LP.S 7
INTRALIPID	LIPD 8
DIALYSIS	DIAL 9
CALORIC.SUP	CSUP 10
HYPERVENT	HVEN 11
OTHER	OTH 88
NO.RX	N 99

CNS.DX4	CNS4
ICH.UNSPEC	ICH 1
SEIZURE	SEIZ 2
HYDROCEPH	HYDR 3
MICROCEPH	MICR 4
INFECTION	INFN 5
ANOMALY	ANOM 6
TUMOR	TUM 7
INCR.ICP	ICP 8
ASPHYXIA	ASPH 9
MYELOMENING	MYMG 10
HYP.ISCH.ENC	HIE 11
ICH.GRADE1	GR1 12
ICH.GRADE2	GR2 13
ICH.GRADE3	GR3 14
ICH.GRADE4	GR4 15
SIADH	ADH 16
OTHER	OTH 88
NONE.NOTED	N 99

FACE.EENT.DX3	ENT3
RLF	RLF 1
CLEFT.LIP	CLIP 2
CLEFT.PAL	CPAL 3
CLEFT.BOTH	CBOT 4
EYE.ABN	EYE 5
EAR.ABN	EAR 6
NOSE.ABN	NOSE 7
MOUTH.ABN	MOUT 8
PHARYNX.ABN	PHAR 9
FACE.ABN	FACE 10
LOWSET.EAR	LEAR 11
MICROGNATH	MGNA 12
TONGUE.ABN	TONG 13
PALPEBRAL	PALP 14
HEARING	HEAR 15
OTHER	OTH 88
NONE.NOTED	N 99

CARDIAC.DX3	CRD3
PDA	PDA 1
PFC	PFC 2
TOV	TOV 3
T/F	T/F 4
TAPVR	TAVR 5
CONRCT	CONR 6
MLH	MLH 7
HRH	HRH 8
ASD	ASD 9
VSD	VSD 10
A.V.CANAL	AVC 11
COMPLEX	COMP 12
TRI.ATR	TR.A 13
PULM.ATR	P.AT 14
TRUNCUS	TRUN 15
EBSTEINS	EB 16
ARRHYTHMIA	AR 17
COR.PULMON	CORP 18
OTHER	OTH 88
NONE.NOTED	N 99

RESP.DX4	RES4
HMD	HMD 1
PN.INFECT	PN.I 2
PN.ASP	ASP 3
PNEUMOTHOR	PNTH 4
PNEUMOMED	PMED 5
PNEUMOPERI	PERI 6
BPD	BPD 7
AIR.OBST	OBST 8
PULM.HEMOR	HEMO 9
APNEA.SP	APNE 10
ANOMALY	ANOM 11
SUBGLOT.ST	GLOT 12
TRANS.TRCH	TTN 13
DIAPHR.HERN	HERN 14
EVENTRATION	EVEN 15
HYPOPLASIA	HYPO 16
OTHER	OTH 88
NONE.NOTED	N 99

GI.DX2	GI2
LIVER	HEP 1
TEF	TEF 2
ESOPH	ESOP 3
STOMACH	GAST 4
SM.BOWEL	INTE 5
COLON	COL 6
PERFORAT	PERF 7
NEC	NEC 8
INFECT	INFN 9
MALROTAT	MALR 10
OBST.JAUND	OBJA 11
DUPLICATION	DUPL 12
HIRSCHSPRUNG	HIRS 13
BLEEDING	BLD 14
SM.L.COLON	SCOL 15
IMPERF.ANUS	ANUS 16
ATRESIA	ATR 17
STENOSIS	STEN 18
WEB	WEB 19
BANDS	BAND 20
VOL.VULUS	VOLV 21
NEC.ILEUS	NEC 22
OMPHALOCELE	OMPH 23
ING.HERN	HERN 24
GE.REFLUX	REFL 25
OTHER	OTH 88
NONE.NOTED	N 99

GU.DX2	GU2
ABN.EXT	EXT 1
ANOMALY	ANOM 2
KIDNEY	KIDN 3
URETER	URET 4
BLADDER	BLAD 5
URETHRA	URTH 6
REN.V.THR	RVT 7
AC.TUB.NEC	ATN 8
TUMOR	TUM 9
OBSTRUCT	OBST 10
INFECTION	INFN 11
POST.VALVES	PVAL 12
HYDRONEPHRO	HYDR 13
CRYPTORCH	CRYP 14
OTHER	OTH 88
NONE.NOTED	N 99

HEMAT.DX3	HEM3
ANEMIA	ANEM 1
POLYCYTH	POLY 2
ABO.INCOMP	ABO 3
RH.DIS	RH 4
HEMOL.OTH	HEM 5
WHITE.CELL	WBC 6
PLTS.LOW	PLTS 7
CLOTTING	CLOT 8
DIC	DIC 9
NEOPLASM	NEO 10
RBC.ABN	RBC 11
HYPERBILI	JAUN 12
OTHER	OTH 88
NONE.NOTED	N 99

SK.MSC3	SK3
MUSCULOSKEL	MUSC 1
GENETIC	GEN 2
METABOLIC	META 3
IMMUNE	IMMA 4
ENDOCRINE	ENDO 5
SKIN	SKIN 6
HAIR	HAIR 7
NAILS	NAIL 8
SYNDROME	SYND 9
ANOMALAD	ANOM 10
LATE.ACID	LNA 11
BIRTH.TRAUM	TRAU 12
HYPOTHERMIA	T.LO 13
RICKETS	RICK 14
THYROID	THYR 15
ADRENAL	ADR 16
OTHER	OTH 88
NONE.NOTED	N 99

INFECTION4	INF4
BACTERIAL	BACT 1
E.COLI	COLI 2
GBS	GBS 3
KLEBS	KLEB 4
STAPH	STPH 5
VIRAL	VIR 6
FUNGAL	FUNG 7
ETIOL.OTH	ETIO 8
SUSPECT	SUSP 9
BL.POS	BL+ 10
CSF.POS	CSF+ 11
URINE.POS	UR+ 12
OTHER	OTH 88
NONE.NOTED	N 99

COMPLICAT	CX
INFECTION	INFN 2
ISCHEMIC	ISCH 3
SLOUGH	SLOU 4
TRAUMATIC	TRAU 5
OTHER	OTH 88
NONE.NOTED	N 99

HEALTH.INSURANCE	INS
NONE	NONE 0
BC/BS	BC 1
MEDICAID	CAID 2
HMO	HMO 3
PPA	PPA 4
OTHER.INS	OTH 88
NOT.KNOWN	UNK 99

OUTCOME	OUTC
DISCHARGED	DISC 1
TRANSFERRED	TRAN 2
DIED.AUT	AUT 3
DIED.NO.AUT	NOT 4

LAB.OTHER* (LBO*): '_____

PROC.OTHER* (PRO*): '_____

RX.OTHER* (RXO*): '_____

DX.OTHER* (DXO*): '_____

Side 2

Figure 1. Admission data form.

Figure 2. Discharge data form.

```
RECORD#          870011
SURNAME          Cameron
FIRST.NAME
MOTHERS.NAME     Carol
ADDR.PHONE*      11111 Lion, Detroit, Michigan, 555-8888
ZIPCODE          48288
HOSPITAL*        Sharp Memorial Hospital
REF.PHYS*        Smith
ATT.INITIALS     mbs
BIRTHDATE        850127
ADMITDATE        850127
SEX              MALE
RACE             BLACK
BIRTHWT          1985
HEAD.CIRC        30.5
LENGTH           45.0
ADM.WT           1990
GEST.AGE         35
G.A.CATEGORY     AGA
NO.BIRTHS        SINGLE
TWIN.A.B         FIRST
APGAR1           7
APGAR5           8
MATAGE           36
MARITAL          MARRIED
GRAVIDA          3
PARITY           2
ABORTUS          1
CHIEF.COMPL      PREM.RDS
PRENAT.DX1       NO.CARE
PRENAT.DX2       NOT.STATED
PRENAT.DX3       NOT.STATED
INTRAPARTUM1     PROM24
INTRAPARTUM2     BREECH
INTRAPARTUM3     CAESARIAN
```

Figure 3a. Portion of admission record.

```
RECORD#          870011
PEAK.BILI        15.9
XRAY*            of the chest showed hyaline membrane disease.
                 Echoencephalogram showed minimal caudate hemorrhages
ABN.LAB.VALS*    negative blood and CSF cultures
RX.DISCH*        20 calorie formula
REM.PROBS*       resolved. A routine eye examination will be scheduled as an
                 outpatient
FOLLOWUP*        by their family physician and Eye Clinic
DX.DISCH*        hyaline membrane disease, hyperbilirubinemia, caudate
                 hemorrhage
LAB.ABNORM1      BILIRUBIN
LAB.ABNORM2      NONE.NOTED
LAB.ABNORM3      NONE.NOTED
LAB.ABNORM4      NONE.NOTED
SURG.PROCEDURE1  CIRC
SURG.PROCEDURE2  ECHOENCEPH
SURG.PROCEDURE3  SEPSIS.WU
SURG.PROCEDURE4  NOT.STATED
TRANSFUSION      PKD.CELL
TRANSFUSION2     NONE.NOTED
TRANSFUSIONS3    NONE.NOTED
DRUGS.GIVEN      GENTAMICIN
DRUGS.GIVEN2     AMPICILLIN
DRUGS.GIVEN3     CEPHALOSPOR
DRUGS.GIVEN4     NOT.STATED
DRUGS.GIVEN5     NOT.STATED
RX.NONDRUG       PHOTO.RX
RX.NONDRUG2      VENTILATOR
RX.NONDRUG3      NOT.STATED
RX.NONDRUG4      NOT.STATED
```

Figure 3b. Portion of discharge record.

```
[*: BODY OF LETTER]
[L]
[L]Baby (FN#NULL)/FN@CAPF/ (FN=NULL)/SEX@DESC/ {}/NAME@CAPF/ was born
{DOB#0} on /DOB@DATE1/
at /HSP*/[*: PLACE OF BIRTH]
{CC<88}[S1]{CC=88}[S2]{}
{FLAG1|FLAG2} and transferred to our NICU
on {ADM#1&ADM#2}/DOA@DATE1/ {ADM=1}the same day {ADM=2}the following day  {}because of
{FLAG1} /CC@DESC/{FLAG2} /CC*/{}.[C1][C2]
[*: CHIEF COMPLAINT AS CODED OR IN EXTERNAL FIELD IF OTHER]
[*: **********************************************************]
[*: PERINATAL INFORMATION]
[L]
[L]{FN#NULL}/FN@CAPF/(FN=NULL)/PRO1@NAME/{} was born
{AGEM#0}[S1][*: MATERNAL AGE GIVEN]
{GRAV#0&GRAV#99}[S2][*: GRAVIDA GIVEN]
{PARA#99}[S3][*: PAROUS GIVEN]{}
{FLAG1|FLAG2|FLAG3}[*: MATERNAL INFO TO PRINT]
{B.NO>1}, the /MULT@DESC/ of /B.NO@DESC/,{}
after a {G.A#0}/G.A/ week gestation,{G.A=0}gestation of unknown length,{}[*: GESTATION
to a
{AGEM=18}n{FLAG1} /AGEM/ year old,{}[*: MATERNAL AGE]
{FLAG2} gravida /GRAV/.{}[*: NUMBER OF PREGNANCIES]
{FLAG3&PARA#0} para /PARA/.[*: NUMBER OF LIVE BIRTHS]
{FLAG3&PARA=0} nulliparous{}
{MART#0&MART#99} /MART@DESC/{}[*: MARITAL STATUS]
{FLAG1|FLAG2|FLAG3} woman.{}[*: CLEAR ALL FLAGS][C1][C2][C3]
```

Figure 4. Letter writing language sample.

March 5, 1985

Frank Smith, M.D.
Sharp Memorial Hospital
1620 Louis St.
Detroit, Michigan 48220

Re: Baby Boy Cameron
(Hospital Record #999011)

Dear Doctor Smith:

Baby Boy Cameron was born on 01/27/85 at Sharp Memorial Hospital and transferred to our NICU on the same day because of prematurity and respiratory distress.

He was born after a 35 week gestation, to a 36 year old, gravida 3, para 2, married woman. The pregnancy was complicated by a lack of prenatal care. Delivery occurred under spinal anesthesia. Events of the intrapartum period included premature rupture of membranes (>24 hr.), breech presentation, and cesarean section. His birthweight was 1985 grams. His Apgar scores were 7 at 1 minute and 8 at 5 minutes.

Prior to transfer to our Neonatal Unit, he had increasing respiratory distress. Infant was meconium stained at birth. After blood cultures were done, antibiotics were initiated. The baby was intubated by the CHM transport team.

At the time of admission to our Neonatal Unit, his weight was 1990 grams. His head circumference was 30.5 cm. His length was 45.0 cm. The physical exam revealed a pink intubated baby with moderate respiratory distress. The X-ray examination of the chest showed hyaline membrane disease. Echoencephalogram showed minimal caudate hemorrhages. Pertinent laboratory values obtained during this admission included negative blood and CSF cultures. The highest serum bilirubin concentration was 15.9 mg/dl.

He received the drugs gentamicin, ampicillin, and cephalosporin. He was transfused with packed cells. Other treatments administered were phototherapy and mechanical ventilation. He required assisted ventilation for 6 days.

Baby Boy Cameron
(Record #999011)
03/05/85 - continued

He was discharged on 02/06/85 at 10 days of age on 20 calorie formula. At the time of discharge, his weight was 1990 grams, head circumference was 30.5 cm, and length was 45.0 cm. The last hematocrit obtained was 57.8% and the last reticulocyte count was 6.6%. His problems at discharge were resolved. A routine eye examination will be scheduled as an outpatient. He will be seen for follow-up by their family physician and Eye Clinic.

Diagnoses at discharge were a preterm male infant, 35 weeks, appropriate weight for gestational age, with hyaline membrane disease, hyperbilirubinemia, caudate hemorrhage.

Procedures done during this hospitalization included circumcision, echoencephalography, and a complete workup for sepsis.

Thank you very much for the referral of this patient. If you have any questions, or if I may be of any further assistance, please do not hesitate to call me at (313)494-5640.

Sincerely,

Mary B. Steward, M. D.
Associate in Neonatal-Perinatal Medicine,
Children's Hospital of Michigan
Associate Professor of Pediatrics,
Wayne State University

MPS/rob

cc: Head Nurse, N B Nursery
Sharp Memorial Hospital
Dr. Small

Figure 3c. Sample discharge referral letter.